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THE ROLE OF GOATS IN FOOD PRODUCTION SYSTEMS IN INDUSTRIALISED AND DEVELOPING COUNTRIES

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THE ROLE OF GOATS IN FOOD PRODUCTION SYSTEMS IN INDUSTRIALISED AND DEVELOPING COUNTRIES

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ABSTRACT. The justification for increasing food production (meat and milk) from goats is associated with an untapped potential. The continuing problem is one of dichotomy: the scientific advances that can be made to respond to increased food production from goats, are not being matched by concerted support within developing and industrialised countries. This is made conspicuous by the fact that 94% of the total world population of goats is found in the developing countries supplying 93% of the total world production of meat and 73% of the milk; Africa and Asia together supply about 90% of the goat meat and 67% of the milk produced. Analyses of projected output and demand up to the year 2000 suggest a widening gap between production and consumption, and is reflected in a decline of per caput supplies of goat meat over the last 20 years. Milk production in the industrialised countries is on the increase. Cheeses are popular and over 400 varieties are known. The prevailing seven production systems are classified in relation to ecosystem, approximate annual rainfall, target regions, type of product and a priority rating in terms of concentrating future effort. Systems combining arable cropping and systems integrated with tree cropping merit high priority in South and South East Asia, and utilisation of intensive grassland in East and West Africa, Central and South America. In South East Asia alone, the existence of 20.3 millions ha of land under permanent crops can support about 40 millions goats which can supply meat to lucrative markets in the Near East. The development strategies include more intensive use of 31 "improver" breeds coupled to clear production objectives, improved use of the feed resources, reproductive efficiency, more innovative productive systems, vigorous research, increased resource allocation and training. These strategies together need to be addressed thoroughly and to elicit wide official support to demonstrate the potential of goats for urgent increased productivity especially in the developing countries.

INTRODUCTION

The principal role of goats is in food production. The particular challenge is to maximise food production in all possible avenues of production using resources that can support high productivity. The justification for this stems

from the fact that the rate of animal protein production has lagged behind human population growth, which in turn has raised doubts about the efficiency of existing animal production systems. More especially, there are doubts about whether ruminants, especially on small farms can be expected to increase production in line with rising demand and higher prices for animal products. In this context, it is therefore appropriate to reexamine the contribution of goats to food production, in relation to both current and potential future contribution.

Among the ruminant animals, the importance of goats and their varied contribution relate especially to small farmers, peasants and landless labourers in the developing countries (Devendra, 1980; Devendra and Burns, 1983), and their value to milk production in industrialised countries (Gall, 1981; Loewenstein, 1982). The lingering question that remains is why is food production from goats one of neglect and continuing low contribution? More specifically, the relevant question that can be asked is : Can the species be made to make a much more significant impact on the animal harvest?

An examination of these questions is therefore of special interest and positive answers are in fact considered quite feasible (Devendra, 1985). The problem however, is one of dichotomy. On the other hand, we have the situation given the enlightened and widespread interest throughout the world, together with the scientific advances that have been made, that goats can be made to be more responsive to the increase food production. On the other hand, we have a continuing situation whereby there is a lack of concerted support within developing and industrialised countries to provide the necessary impetus for food production. This is evident from a recent World Bank (1983) report based on an analysis of 80 research and/or development projects on a regional basis. Even more serious is the fact that the disparity between production and human requirements is rapidly widening.

Clearly, until and unless the species is more widely and totally accepted as an important component of the animal genetic resources at all levels by those concerned with food promotion and processing, it is quite likely that under exploitation and low production will continue to prevail.

During the last two decades, there has been a perceptible and positive shift in interest towards the development of goats. It is necessary however that this momentum be accelerated in order to ensure that goats make a major impact on food production in the future. This paper is concerned with examining these issues and particularly the strategies that can be vigorously pursued to augment future food supplies from goats especially in the developing countries.

POPULATION AND PRODUCTION

Table 1 summarises the types and extent of the animal genetic resources found in the developing countries. It is significant to note that of these, almost all the buffaloes, and about 94% of the goats are found in the developing countries. The position regarding goats is unique on account of the fact that they are widely distributed throughout the climatic extremes, from temperate-wet, arid and semi-arid to the sub humid and humid tropics. Table 1 also indicates that within the developing countries, goats produced approximately 93% of the goat meat and 73% of the goat milk out of the total world production.

Table 2 sets out the distribution of the total world population of goats by region. It is relevant to note that Africa and Asia together accounted for 88.4% of the population. In these two continents also, goats formed about 24 - 29% of the total population of grazing ruminants. With the exception of Oceania where the annual growth rate of goats was especially high, the overall growth rate was around 1.0% in both developed and developing countries.

MEAT AND MILK PRODUCTION

Table 3 presents the contribution by goats to meat and milk production. Throughout the developing countries, meat production is of primary importance, followed by milk, whereas in the developed countries by comparison, milk was more important. Parallel to the high populations in Africa and Asia, these regions also produced about 90% of the total amount of meat and 67% of the milk produced. In N.C. America, Europe and the U.S.S.R., goat milk was more important than meat which is consistent with the situation for the developed countries.

An important question related to food production by goats is the trend in the supply of goat meat and milk. Table 4 examines this trend for the time periods 1961-65 to 1974 and 1975 to 1984 for the developed and developing countries. The table indicates that over these periods, the rates of growth of the goat populations, and meat production are decreasing. This trend is to be expected since increased availability of goat numbers automatically affect the quantum of meat produced.

By comparison, the situation regarding milk production is opposite, and in both the developed and developing countries it is increasing. The increased growth of milk production in the developing countries is somewhat surprising, but is probably due to increased use of improved dairy goats from temperate countries such as Australia, England, France, Switzerland and the United States of America.

In view of the primary importance of goat meat, it is of further interest to see the real trends in terms of the percentage of carcass meat accounted for by goat meat and the per caput supply over the three time periods 1961-1965, 1974 and in 1984. Table 5 attempts to examine this trend. Without exception, the situation in all regions and notably in Africa and Asia is that the contribution by goat meat is on the decline. Concerning per caput goat meat supply, the overall trend is also static in Africa, N.C. America, Asia and Oceania, and declining in South America.

Demiruren (1982) has projected that in 14 selected countries, the demand for goat meat and milk in 1990 will need 2.8% increased production above the present levels of per caput consumption. Given the present static rates of growths in these products, and the decreased trend in per caput supply (table 5), it is unlikely that his projections are going to be met. This point is also supported by the report (TAC, 1985) that projections for the demand for sheep and goat products up to the year 2000 indicate that the gap between production and consumption is increasing faster than for other food commodities.

A consideration of the data in tables 4 and 5 thus suggest that the current contribution of goats to meat production in relation to human population growth, is therefore one of decline and presents a situation which must surely be of much concern.

There are at least six interrelated developments and these are note-worthy :

(i) Inadequate supplies of goat meat have resulted in a trend towards the increased price of per unit of goat meat relative to all other meats. This is reflected in many countries such as in the ASEAN region (Devendra, 1979a), also the Near East (Devendra, 1985b) and elsewhere.

(ii) There have been increased imports of feral goat meat notably from Australia, New Zealand to markets in the Near East and the West Indies.

(iii)The high price of goat meat has encouraged unscrupulous substitution by imported mutton from poorer quality sheep.

(iv) Inadequate goat meat supplies have also resulted in the increased price of live goats, including breeding animals.

(v) The demand for goat meat has encouraged increased slaughter of breeding animals with a consequent erosion of the base population in quantitative and qualitative terms.

(vi) The reduced availability of improved breeding animals has also resulted in some countries to shift from goats to sheep production.

Self sufficiency ratios calculated on assumptions concerning population growth, trends in per capita income, income elasticity of demand and projected consumption of meat in 1990 and 2000 including detailed analyses of projected output and demand for all meats, suggests that the trend will be towards a widening gap between output and demand (Sarma and Yeung, 1985). Table 6 indicates that the self-sufficiency ratios for meat and milk are lowest in North Africa/Middle East and Sub-Saharan Africa.

In regard to these developments, and the projected output and demand for meat, two major conclusions emerge. Firstly, goat meat supply is on the decline. Secondly, developing countries cannot remain complacent and need to aggressively address the issue of increasing food production from goats for both national and international markets, especially those in the Near East. Strategies must thus be urgently developed that can alleviate the present circumstances. The situation is compelling as remedial measures are not forthcoming. Failure to grasp this opportunity now by the developing countries will mean losing out to other export-oriented industrialised countries.

The quantitative and qualitative aspects of meat production from goats has been recently reviewed (Devendra and Owen, 1983). It is generally believed that goat meat has more lean than mutton (Devendra and Burns, 1983), and this is associated with less subcutaneous and intermuscular fat than sheep (Ueckermann, 1969; Owen et al., 1977, 1978; Ladipo (1973). The total edible and commercially valuable portions of the carcass are important aspects of economic goat production. Table 7 indicates that these values are high in many developing countries in the tropics. In temperate countries, a recent development has been the use of goat meat in the sausage industry. Up to 20% goat meat has been used in frankfurters (Eggen et al., 1973; Marshall et al., 1977). The addition of up to 40% had little effect on processing characteristics or palatability. In the Philippines, goat meat has been mixed with pork fat up to 50% in sausages without being discriminated by taste panelists (Arganosa, Bandian and Ibarra, 1979).

MILK AND MILK PRODUCTS

Milk and milk products especially in the developed countries are of growing importance. In the U.S.A. and parts of Europe, there is increasing recognition being given to the

value of goat milk and milk products, especially cheese. By comparison in the developing countries, goat milk is also highly sought after, but its most important contribution is the supply of proteins and minerals to children, peasants and pregnant mothers in rural areas who do not have access or the means to buy cow milk. For example, the 32 g protein supply of 1 litre goat milk represents 70% of daily requirements (46 g) of a lactating or pregnant peasant mother and is adequate for the daily needs of a child up to 11 yr of age. The Ca supply of 1.7 g/l is also adequate to meet the daily requirements (Devendra, 1979b). The nutritive value of goat milk is of special interest; Jenness (1980) has recently reviewed this aspect in detail.

Goat, cow and human milks are approximately isocalaric and supply about 3.10 MJ/l of energy, but there are differences in the proportions of the energy derived from lactose and protein. In goat and cow milk, fat, protein and lactose account for about 50, 25 and 25% of the energy, but in human milk they furnish 55, 7 and 38%. Calculations of the nutritional adequancy of goat milk for human infants (Jenness, 1980) demonstrated that the supply of protein, calcium, phosphorus, vitamin A, thiamin, riboflavin, and pantothenate were in excess (Figure 1). On the other hand, it was deficient in iron and vitamin A, B12 and C. Goat milk like cow milk, had a satisfactory balance of essential amino acids equalling or exceeding the WHO (1973) requirements.

Three special attributes of goat milk are worthy of mention :

(a) The fat globules are small in size. While the range of size of the fat globules is the same as the cow (1 - 10 μm in diameter), the content of smaller globules is greater (Fahmy, Sirry and Safwat 1956). Up to 4.5 μm in diameter, the percentage distribution of fat globules was 85.7% in sheep, 82.7% in goats, 62.4% in cow and 40.9% in buffalo milks.

(b) The fat and protein contents are more easily digestible. Tubercle bacillus is rare and there are also anti-allergy properties. Thus goat milk can replace cow milk for those allergic to the latter.

(c) The vitamin A is carried intact.

Although goat milk is used for direct consumption, the milk products are probably more popular. These include cheese, butter and yoghurt. Cheese are particularly popular and in the Mediterranean and Europe over 400 varieties and 800 names of cheeses have been described (Goerner, Palo and Bertan 1968). Either pure goat milk or goat milk combined with cow, buffalo or sheep milks may be used (Delforno, 1977). Fresh cheese ("Queso Blanco" in Latin America), soft cheeses (Greek "feta") or hard cheeses ("Chevrotin" in

France) can be produced.

In Cyprus "halloumi", a semi-hard cheese is produced and is widely consumed. Other goat milk products include low fat, fortified, flavoured or condensed milks, buttermilk, butter and ice-cream; the data on these however, is very limited (Lowenstein et al., 1980).

PRODUCTION SYSTEMS

The production systems for goats are diverse in different regions and have been evolved over the years as an enduring response to the environment and the pattern of crop production and farming systems. The systems are especially dependent on the agro-ecological environment and goats like other ruminants, must always depend on the available vegetation or crops for the feed base. The agro-ecological environment is especially important for example in the more arid regions, the sparse vegetation provides a week feed resource base. Thus, the production systems are primarily nomadic. By comparison in the humid tropics, sedentary systems are more common which enable more complex crop-livestock systems to develop.

Goat production systems can be classified into the following categories :

(i) Very extensive to include :
  (a) cold and wet highland areas such as the Himalayan and Alti-Plano, and
  (b) extremely dry arid and semi-arid regions.
(ii) Extensive systems,
(iii) Systems combining arable cropping to include :
  (a) roadside, communal and arable grazing systems,
  (b) tethering
  (c) cut-and carry systems,
(iv) Systems integrated with tree cropping.
(v) Intensive grassland.
(vi) Nomadism, and
(vii) Transhumance.

A comprehensive discussion of these production systems is appropriate.

(i) Very Extensive Systems

This system involves very large areas of unproductive or marginal land which is unsuitable for crop production. It also includes those areas that are subartic because of altitude or latitude such as the Himalayan region where continuous mountain ranges are interspersed with high valleys. Here goat production is predominantly transhumant with herders moving their flock from seasonally available grazing areas involving winter grazing, spring foothill grazing, summer mountains pastures or use of crop residues. The

Peru where the production system is primarily sedentary with animals being taken to pasture daily on the sparse rangeland. Crop residues are fed as supplements.

The annual rainfall is generally less than 500 mm. The vegetation is very sparse in the arid regions and stocking rates are usually below 0.1 ruminant livestocks unit (1 ruminant livestock unit, RLU = 1 Buffalo, = 0.8 Cattle = 0.1 Goats or Sheep). The very dry conditions and sparse feed

base makes these situations suitable for goats, but control of numbers is essential in these fragile ecologies to prevent damage to the environment such as in the Sahel.

The question of overgrazing and damage to the environment especially in these environments does exist, but this should no longer be considered constraint in the light of improved husbandry practices, grazing management and control of numbers.

(ii) **Extensive Systems**

This system is by far the most common for goats in most regions. It is characterised by goats usually owned by small farmers and peasants, grazing on all available grazing areas, largely uncultivated, including marginal land, for varying periods during the day. The length of the grazing period is dictated largely by the type of animal kept and the objectives of production : meat or milk.

The system has certain very definite features. Usually, more animals tend to be carried per hectare than in the intensive system, probably because of the fact that these animals have access to plenty of grazing land. Goats and sheep are usually grazed together probably because goats tend to lead the herd. The rainfall is generally higher (500 - 1200 mm/annum). The flock sizes are larger (1 - 15 head) and animals, often goats and sheep belonging to several owners are often run together and brought back in the evening. Stocking rates are usually in the range of 0.1 - 0.4 RLU/ha. A low level of unpaid family income represents the main input. The use of this unpaid family labour, usually women and children, represents an aspect of effective labour use enabling the rearing goats to be an important component of farm income (Devendra, 1976). The system is principally one of low resource use, and a generally low level of productivity emerges from sub-standard nutritional management whereby very little or no concentrates, salt or mineral licks are provided.

(iii) **Systems Combining Arable Cropping**

Ruminant production systems combining arable cropping have evolved in situations where crop production is important to contribute to the stability of the system. Animals do not compete for the same land and play a supplementary role as

arable cropping. Three types of systems are common as follows :
(1) roadside, communal and stubble grazing,
(2) tethering, and
(3) cut-and-carry feeding.

The three are not mutually exclusive and are typical of many countries in South and South East Asia, parts of the Near East, many parts of Africa, Central and South America. Grazing on roadsides and on communal (waste) land may be practised by landless stock owners as well as others. Grazing is restricted to periods immediately after harvest when the feeds available consist of the aftermath (viz. stubble and some regrowth from the stubble), any weeds, and browse from shrubs and trees that grow in it. Where multiple cropping is practised, stubble grazing may be severely restricted or non-existent.

An area that is potentially very important for goat production is the tsetse fly infected area in West Africa through the Congo basin to the lowlands of East Africa. The feed resource base of mainly grass and crop residues is underutilised. The possible wider use of the West African Dwarf goat which is trypanotolerant thus represents an important strategy.

Tethering is adopted when there is a need to prevent goats wandering into areas being cropped, and also to ensure use of the available feed in a given area before they are moved. This type of confinement feeding is most popular in South East Asia and Central America because multiple cropping is very widespread in these regions. The animals may be tethered on waste grazing areas close to the farm or on rice fields after harvest to regulate stubble grazing or close to stacks of crop residue to allow self-feeding.

In the cut-and-carry system a large proportion of the feed is usually brought in from outside the holding because of the small size of holdings in relation to the number of animals kept. The system is subject to the vagaries to seasonal abundance and shortage of forage that characterise it. Since goats are housed most of the time, this results in a growing dependence on high priced concentrate feeds during lean periods.

The cut-and-carry or stall feeding system requires high labour and capital investment. It is a system that favours situations where there is no land or more particulaly, the availability of abundant supplies of crop residues and agro-industrial by-products. Probably because of the higher capital investment, it has not been adequately explored and is underestimated. Its value has however, been demonstrated in Fiji (Hussein et al., 1983), India (Sehgal and Punj,

1983), Nigeria (Ademosum, Jansen and Van Houtert, 1984) and Cyprus (Hadjipanayiotou, 1984).

(iv) **Systems Integrated with Tree Cropping**

This system is especially common the humid and sub-humid regions where there is intensive tree crop production, coconuts, oil palm and rubber. Although the system is not new, integration with these tree crops to ensure more complete utilisation of the land has not been given adequate attention. The advantage of the system are :

(1) Increased fertility of the land via the return of dung urine,
(2) Control of waste herbage growth,
(3) Reduced use of weedicides,
(4) Reduced fertiliser wastage,
(5) Easier management of the crop, and
(6) Distinct possibilities of increased crop yields, consistent with greater economic benefits including sale of animals and their products.

Considering the large area under such tree crops as coconuts, oil palm and rubber in some countries in South East Asia and the Pacific islands, the potential carrying capacity and offtakes of meat (goat meat and/or mutton) from the land is therefore enormous. Others include the eastern coastline of East Africa, West Africa, parts of Central America and the Caribbean, and the Pacific island territories, notably Papua New Guinea, New Hebrides, Fiji, Solomon Islands and Western Samoa. The total land area under tree crops is enormous and hence the potential for integrating goats or sheep into them.

In South and South East Asia alone, the potential for this kind of activity is reflected in an estimated area of approximately 20.3 million hectares under tree crops (F.A.O., 1984). In Malaysia for example, the combined total hectarage under rubber and oil palm is approximately 4.3 millions. Assuming a carrying capacity of 3 animals/ha, the total number of animal equivalents in only half the land area is about 5.2 million, which is substantial.

The economic benefits of integrating goats with oil palm are shown in the results in Table 7 where the differences in yield over four years in favour of grazing cattle and goats was 2.15 - 5.16 mt fresh fruit bunches/ha/yr with a mean value of 3.51 mt of fresh fruit bunches/ha/yr. The economic advantage of the sale value of the fresh fruit is conspicuously substantial. The result in economic terms is similar to the findings in West Java of integrating goats and sheep with rubber (Table 8). The presence of legumes is of definite advantage, and calculations of the amount of N utilised by the animal and also excreted in the faeces and

urine increases with increasing presence of the legume cover (Chee and Devendra, 1981).

(v) **Intensive Grassland**

Intensive grassland production is feasible when land is not a constraint and where there is adequate rainfall. This is achieved by the use of superior seeds, higher fertiliser application (N, P and K) rates and improved cultural practises. Examples of improved grasses that are commonly cultivated throughout the sub-humid and humid regions are Guinea grass (Panicum maximum), pangola(Digitaria decumbens), paspalum (Paspalum conjugatum), Napier (Pennisetum purpureum) and setaria (Setaria sphacelata). Stocking rates are much higher and are about 0.6 - 2 RLU/ha.

The system is not common in regions such as Asia where land for grazing is not available. In Central and South America where by comparison, grazing land is available, the system is common. In Mexico, several studies have been reported using ryegrass pastures (Lolium perenne) for goat milk production with stocking rates of between 40 - 95 goats/ha (Loza, Gonzalez and Claveren, 1978; Martinez and Salinas, 1978; Juarez and Peraza, 1981). Likewise, carrying capacities of 37 - 45 and 30 - 40 goats/ha have been used for meat production on Pangola grass (Digitaria decumbens Stent) and S. sphacelata pastures (Devendra, 1971; Chen and Devendra, 1984).

The value of goats for meat production raises the issue of comparative biomass production with beef and cattle on herbage. Direct experimental comparisons on this issue are unfortunately very limited, and in any case difficult to interpret because of differences in grazing habits. Also, live weight gains are a function of adult live weight and the genetic potential for growth. In terms of efficiency of meat production, this is approximately the same between species. However, the indisputable advantage that goats have over cattle is that cattle cannot exceed an annual reproductive rate of 1.0 whereas goats can easily achieve 1.5. Since reproductive rate is dominant in meat production, biomass production from goats is clearly much higher than in cattle.

Additionally, the prices of goat meat are often higher than that of beef in many countries, implying that goat meat production is very economic. Thus in situations where production of goat meat is economic, the choice of species is important in the efficient utilisation of grasslands.

(vi) **Nomadism**

Nomadism involves the regular movement of whole families and tribes in search of grazing and water. It is character-

istic of bedouin tribes in West Asia and North Africa. Flocks may consist of goats or sheep only, or mixtures of both species. Management practices are the outcome of centuries of adaptation to peculiar and difficulty physical environments; a limited number of crops can be grown, but goat and sheep-rearing is a principal livelihood. In the Near East, poor water supply determines the traditional systems of grazing areas with sparse vegetation of mainly weeds.

During the long dry season, the goats are grazed close to water points and are watered either daily or every other day. The hamlets are separate and independent of the camel camps, and each family has its own separate pen for the goats and the sheep. In the Rift Valley, lack of grazing rather than lack of water is the motivation for nomadism. The Turkana nomads of this region divide their stock into animals that browse (camels and goats), and animals that graze (cattle) grazing with the first rains. Flock sizes of goats and sheep are large and can vary from 100 - 800 heads.

Nomadic livestock management has three features :
(1) Herd diversification: different species with their different grazing habits (for example, browsing by goats), reduce the probability of total loss of all animals.

(2) Loaning animals and sharing herds: this enables sharing livestock with others in another area if there is a drought. Also social contacts are strengthened.

(3) Movement of herds: this is an obvious strategy for survival and includes various types of migration : seasonal, short-distance or long-distance disaster migrations.

(vii) **Transhumance**

Transhumance or semi-nomadism, while it is also a migratory system differs from nomadism in that it usually involves some shifting arable cultivation in rain-fed areas or even sedentry systems in villages, rural-fringe areas or at oases during certain seasons of the year (Wilson and Clark, 1975).

Several patterns of alternating sedentary crop cultivation with migration to grazing areas exist in different parts of the world, mainly in semi-arid areas or areas with extended dry periods:

- Alternation between winter quarters in the plains and valleys and summer mountain grazing areas; there may be an overlap between transhumant and nomadic people, the latter entering grazing grounds which are left by transhumants for summer grazing.
- winter grazing in desert areas, summer grazing in oases and

irrigated cropping areas;
- grazing in plains and valleys which are left during the rainy season when they are flooded and sometimes cannot be used because of disease risks (tse-tse and parasites).

These movements sometimes follow fixed annual routes. Sometimes the extent of movements from the cropping area is varied according to available feed. The flock sizes are smaller and are about 100 - 300 animals.

FEED RESOURCES

With the exception of perhaps the more temperate and industrialised nations, the major constraint in all production systems in the developing countries is feed. The problem varies from region to region, but is most acute in the arid and semi-arid regions such as northern Africa and the Near East due to very low annual rainfall and poor crop production. By comparison in the humid tropics such as in South East Asia, East and West Africa and Central America, feed is more abundant due to high annual rainfall, intensive crop production, abundant crop residues and also considerable shade which are beneficial to goats.

Together with feed as the major constraint, a concurrent problem is that of widespread inefficiencies in the use of the available feeds in all regions in the developing countries. There are three major observations in this regard:

1) Extensive systems are the most widely practised and these generally follow a pattern where the goats go in search of the feed or utilise whatever sparse feeds that are accessible to them. The system is also disadvantageous from the standpoint of control over numbers and possible damage to the environment.
2) Intensive feeding systems are generally rare in the humid tropics in terms of utilising abundant crop residues, or in Central and South America where nitrogen fertilised pastures are used for meat and milk production.
3) There exist considerable opportunities to use non-conventional feed resources to include non-protein nitrogenous sources and leguminous forages that can significantly enhance performance. In Asia and the Pacific for example, there is an annual production of approximate 194 x 10^6 tonnes goats (Devendra, 1985d), of which about 93% of the feeds are suitable for feeding ruminants.

A generally low level of nutrition and inefficient feeding systems that cannot supply adequate nutrients for production, result in poor performance. This is evident in the results of several studies such as those in India (Sachdeva et al., 1974; Parthasarathy et al., 1983) and

Malaysia (Devendra, 1979a).

Increased production from goats in the future, consistent with more complete use of the goat genetic resources, will require a significant shift from the extensive to more intensive production systems. This will require in particular, more innovative feeding systems that can take full advantage of the available dietary ingredients and can identify the objectives of production (meat, milk, fibre or skins) clearly in terms of production and profitability. In this context, it is essential to have full understanding of the particular abilities of potentially important "improver" breeds, their feeding behaviour and response within individual environments.

DEVELOPMENT STRATEGIES

Increasing food production from goats calls for major emphasis on a number of development strategies. The following inter alia merit special attention:

(i) **Extending the use of goat breeds**

Table 9 sets out the various "improver" breeds that are of potential importance. 31 individual breeds are identified in relation to their speciality and country of origin. It is unfortunate that of these less than six are currently being used for large scale improvement programmes within and outside the region of origin. Clearly, much more use can be made of these in breeding programmes to increase production.

For meat production, increased numbers are essential and for which prolific breeds are valuable. Calculations of biomass production from prolific breeds compared to non-prolific breeds clearly demonstrate this (Devendra, 1985e). Using a standard of 1.6 kids per birth, there exist at least 19 prolific breeds, 16 of which are found in the developing countries. Again, very few of these breeds are being used for large scale meat production.

(ii) **Production Objectives**

Clear production objectives are essential to relate the use of the available breeds, other production resources,promoting market demand and consumer preferences. In respect of goat meat and milk, the following considerations are relevant :

(a) Goat Meat

Quantity - Total amount of lean meat in the carcass (measured by live weight before slaughter), growth rate and efficiency of production, total number of animals available for slaughter and amount of meat per animal. Total weight of offspring weaned/year/female

is important.
Quality - Quantity and distribution of fat (excess undesirable). Taste factors.

(b) Goat Milk
Quantity - Total yield, lactation, length, persistency and number of lactations.
Quality - Milk composition (butter fat and solids non-fat).

Although goat meat is of primary importance, milk is also an important contribution by goats. A flatter lactation curve means that goats are more persistent milk producers (Devendra, 1979b). Even more important is the finding in India (Chauhan and Balishter, 1983) that goats are more economic producers of milk than buffaloes. This is significant since buffaloes in India produce 60-65% of the total volume of all milk produced. Table 10 demonstrates that with marginal farmers or landless labourers, input-output ratios between buffaloes and goats were higher for the latter and justified the investment on goats.

In many parts of the tropics, goats are often used for dual purpose, for meat and milk. Good examples of dual purpose breeds are Anglo-Nubian are the Barbari, but several other breeds are also used likewise. The use of goats for dual purpose production, meat or milk production also allows for specialisation for one or the other or both types of production.

(iii) **Reproductive Efficiency**

The task of maximising numbers and ensuring survival is a particularly important strategy to increase productivity from goats. It is also as important component of improvement programmes.

Improvements to reproductive efficiency can significantly influence the objective of increasing numbers born and the output of products. Reproductive rate is the all too important factor and the build up of numbers is associated with the following components :

(i) Age at first mating (females)
(ii) Productive life span of males and females
(iii) Annual mortality in the breeding flock

This is influenced in turn by :
a) Percent of breeding females failing to bear
b) Percent of breeding females producing multiple births
c) Frequency of parturition, and
d) Mortality rate up to first mating

(iv) **Improved Use Of Feed Resources**

Improved use of the feed resources is essential to support not only higher performance, but also increased numbers. The basic strategy is to produce sufficient amounts of feed of good quality that are available all the year round.

A shift to move more intensive production systems is desirable and can be coupled to increased use of the available crop residues, agro-industrial by-products and also non-conventional feeds especially in systems combining arable cropping. Expanded use of nitrogen supplements especially from proteinaceous legumes like leucaena (Leucaena leucocephala), sesbania (Sesbania grandiflora) and pigeon pea (Cajanus cajan) and also non-protein nitrogen sources like urea can significantly increase intake and performance.

In the Near East, it is estimated that 40 millions ha could be used for increased dry matter (DM) production. The outstanding successful development in Syria, of the ancient and traditional system of grazing control, the hema, merits special mention. It includes inter alia introducing Atriplex spp., planting of fodder trees and creation of cooperatives. In draught prone western India, the introduction of Cenchrus ciliaris and Lasiurus sindicus has increased DM yield from 0.4 to 3t/ha/annum (Jain, 1983).

(v) Ex**ploiting the production systems**

Exploiting the prevailing production systems represents a most important means of accelerating production. Table 11 attempts to classify the type of production system relative to the ecosystem, approximate annual rainfall, the target region and the type of product appropriate to the system. In particular, the last column in table 11 gives a priority rating for concentrating future effort.

The very extensive, extensive, nomadism and transhumance production systems are primarily found in North Africa and the Near East, and in a situation where climate represents the principal limiting factor. Since increases in the total feed available are likely to be minimal, the priority for future effort is considered to be low. By comparison, systems combining arable cropping, systems integrated with tree cropping and intensive grasslands are of high priority within which there exists significant possibilities for increasing productivity.

In South and South East Asia for example, there exists (F.A.O., 1984), 20.3 million hectares of land under permanent crops. This area is essentially unused and is potentially valuable if some of it can be integrated with either goats or sheep for meat production. Assuming an average stocking rate of 4 goats/ha and even if only half this land area of 10

millions hectares is utilised, the total number carried is quite sizeable (Devendra, 1986). At an approximate slaughter weight of 20 kg, the potential biomass production is 800,000 tonnes, which represents about 79% of the combined current production of goat meat and mutton from goats and sheep in South and South East Asia. This avenue of production can be exploited much more fully and merits high priority in research and development programmes.

(vi) **Research, Linkages and Training**

Continuing research is vital to sustain progress not only nationally, but regionally, in which linkages can significantly promote further progress. Currently, goats like sheep, are given low priority in research and development programmes (World Bank, 1983; TAC, 1985), suggesting that much more research and development assistance is justified. Equally important, there is also a need to emphasise training to ensure effectiveness of the total effort. Most colleges and universities do not include goat production in their curricula and this issue also needs to be corrected.

CONCLUSIONS

Over the last two decades, the increased interest in the role of goats in food production systems in both industrialised and developing countries has been spectacular. Associated with this interest, there has been a perceptible increase in research and development activities, very much more than in the past. These however, are generally inadequate and suffer from lack of a concerted thrust and adequate resource use in the developing countries that can focus specifically on goats. Consequently, the disparity between production and human requirements is rapidly widening, and is reflected in declining per caput supplies of goat meat.

The thesis of this paper is that the present trend can be improved, and goats can be exploited much more fully to respond to increased food production. This primary aim calls for very much more commitment and wider official support by both national governments and international agencies. The issues relate to the apparent failure to exploit more fully, an undeniable opportunity to promote the development of the species. It also relates to policy issues concerned with the development of goats within the livestock sector in individual countries and also regionally. Progress will come from a definite shift from the present situation of just acknowledgement of value and token support, to increased resource allocation and the use of production resources. Failure to correct this situation will relegate the species, despite all the attributes and potential value, to be unresponsive to the need for more animal protein, socio-economic impact of ownership to the rural poor, changes in technology, domestic and foreign consumer patterns. Thus the constraints to more effective use of goats need to be

viewed much more throughly than in the past, in the context of viable solutions, the new thrusts that are necessary, increased resource allocation and predictable future contribution. These objectives need to be examined urgently, to initiate appropriate strategies, the success of which is simply dependent on whether there is the will to pursue demonstration of the potential of goats for increased productivity throughout the world.

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Species	Population (10^6)	As % of World Population	As % of World Production	
			Meat	Milk
Buffaloes	125.4	99.4	98.8	99.7
Cattle	844.4	66.4	27.9	16.1
Goats	432.7	94.1	92.8	73.2
Sheep	595.3	52.2	44.0	54.8
Pigs	445.6	56.6	36.6	-
Chicken	4108.0	56.2	31.8	-
Ducks	131.0	82.4	-	-

TABLE 1 THE ANIMAL RESOURCES AND THEIR CONTRIBUTION TO FOOD PRODUCTION IN DEVELOPING COUNTRIES (F.A.O., 1984)

Region	Population (10^6)	Distribution (%)	Av. Growth Rate/Yr+ (%)	As % of Total grazing ruminants++
Africa	151.0	32.9	1.0	29.1
N.C. America	14.0	3.1	1.0	6.3
S.America	19.8	4.3	0.2	7.0
Asia	255.2	55.5	1.0	23.8
Europe	12.5	2.7	0.8	4.3
Oceania	0.4	0.1	18.8	0.2
USSR	6.5	1.4	1.2	2.4
World	459.5	100.0	1.0	15.3
Developed	26.9	5.8	1.0	2.7
Developing	432.7	94.2	1.0	21.7

\+ Over the period 1975 to 1984.

++ Buffaloes, cattle, goats and sheep.

TABLE 2. THE WORLD POPULATION OF GOATS BY REGION. (F.A.O., 1984)

Region	Meat	As % of total production (%)	Milk	As % of total production (%)
Africa	609	29.8	1483	19.8
N.C. America	30	1.5	351	4.7
S. America	64	3.1	136	1.8
Asia	1222	59.8	3546	47.2
Europe	86	4.2	1658	22.1
Oceania	2	0.1	-	-
USSR	30	1.5	330	4.4
World	2042	100.0	7504	100.0
Developed	148	7.2	2014	26.8
Developing	1894	92.8	5490	73.2

+ From buffaloes, cattle, goats and sheep

TABLE 3. THE CONTRIBUTION OF GOATS TO FOOD SUPPLY BY REGION (F.A.O., 1984; 10^3 TONNES)

Characteristic		Period 1961/65-1974(%)	Period 1975-1984(%)
I.	Goat Population		
	Developed	2.8	1.0
	Developing	2.1	1.6
II.	Meat Production		
	Developed	1.4	-0.2
	Developing	6.3	2.6
III.	Milk Production		
	Developed	-0.3	1.0
	Developing	1.2	2.5

TABLE 4. TRENDS IN THE ANNUAL RATES OF GROWTH OF THE GOAT POPULATION, GOAT MEAT AND MILK PRODUCTION IN THE DEVELOPED AND DEVELOPING COUNTRIES (F.A.O., 1984).

Region	% of indigenous production+			Per caput goat meat Supply (Kg/yr)++		
	1961-65	1974	1984	1961-65	1974	1984
Africa	9.9	8.2	9.4	1.20	0.91	1.13
N.C. Amercia	0.1	0.1	0.1	0.06	0.06	0.08
S. Amercia	1.0	0.5	0.6	0.43	0.32	0.24
Asia	5.0	3.9	3.9	0.47	0.40	0.44
Oceania	0.1	0.1	0.1	0.12	0.10	0.11

+ As percentage of beef and veal, mutton and lamb, goat meat, buffalo meat, pig and poultry meats.

++ Includes offals.

TABLE 5. THE PERCENTAGE OF THE INDIGENOUS PRODUCTION OF CARCASS MEAT ACCOUNTED FOR BY GOAT MEAT AND PER CAPUT SUPPLY IN 1961-1965, 1974 AND 1984 IN SELECTED REGIONS (F.A.O., 1974 ; 1984).

Product/Period	Asia	North Africa/ Middle East	Sub-Saharan Africa	Latin America
Meat+				
1961-65	97	95	103	112
1973-77	94	89	103	108
1990	73	62	77	96
2000	61	52	57	91
Milk+				
1961-65	94	94	91	92
1973-77	93	87	82	92
1990	79	67	53	91
2000	71	57	38	96

+ Includes beef, veal, buffalo meat, mutton and goat, pig and poultry meat.

++ Includes cow, buffalo, goat, sheep, camel and milk products (expressed as whole milk equivalents).

TABLE 6. SELF-SUFFICIENCY RATIOS FOR LIVESTOCK PRODUCTS BY REGION, 1961-65 AND 1973-77 AVERAGES AND PROJECTIONS TO 1990 AND 2000 (Adapted from Sarma and Yeung, 1985).

Breed	Location	Total Edible (%))	Total Commercially Valuable (%)	Reference
Small East African[1]	Uganda	48.3	55.5	Wilson (1958)
Katjang[1]	Malaysia	61.2	81.5	Devendra (1966)
Indigenous[2]	Malawi	74.5	80.5	Owen (1975)
Indigenous[2]	Botswana	72.3	79.6	Owen et.al.(1977)
Indigenous[3]	Botswana	71.8	79.2	Owen et al.(1977)
Indigenous	Botswana	74.3	80.9	Owen et al.(1977)
Boer[2]	Botswana	70.0	78.0	Owen et al.(1977)
Katjang	Malaysia	71.5	96.2	Devendra (1980)

1 Females

2 Males

3 Males castrates

TABLE 7. ESTIMATES OF TOTAL EDIBLE AND TOTAL COMMERCIALLY VALUABLE MEATS - PERCENTAGES FOR VARIOUS BREEDS OF ADULT GOATS IN THE TROPICS.

Year	Grazed area (Yield of fresh fruit bunches/ha/yr,mt)	Non-grazed area (Yield of fresh fruit bunches/ha/yr,mt)	Difference fresh fruit bunches ha/yr,mt)
1980	30.55 (C)+	25.61	4.94
1981	17.69 (C)+	15.87	1.82
1982	25.12 (C + G)++	22.97	2.15
1983	23.45 (C + G)	18.29	5.16
Mean	24.20	20.69	3.51

+ = cattle

++C + G = cattle + goat

TABLE 8. THE EFFECT OF MIXED CATTLE AND GOAT GRAZING ON THE YIELD OF FRESH FRUITS IN OIL PALM CULTIVATION IN MALAYSIA (Devendra, 1985c).

Speciality	Breeds	Country of Origin
Milk High yield	Alpine	Switzerland;temperate,wet
	Anglo-Nubian*	UK: temperate, wet
	Saanen*	Switzerland;termperate,wet
	Toggenburg	Switzerland;temperate,wet
Medium yield	Barbari	India;tropical,dry
	Beetal	India;tropical,dry
	Black Bedouin	Israel,Egypt;tropical very dry
	Damani	Pakistan;tropical,dry
	Damascus*	Syria,Lebanon;subtropical, dry
	Dera Din Panah	Pakistan; tropical dry
	Jamnapari	tropical/subtropical, dry
	Kamori	Pakistan;subtropical,dry
	Kilis	Turkey; subtropical, dry
	Malabar	India;tropical, humid
	Marwari	India;tropical, dry
	Sudanese Nubian	Egypt and Sudan; tropical dry
	Zaraiby*	Egypt; tropical, dry
Meat	Anglo-Nubian*	
	Boer	S. Africa;subtropical, dry
	Fijian	tropical, humid
	Jamnapari	
	Katjang	Indonesia, Malaysia; tropical, humid
	Ma T'ou	China; subtropical, humid
	Sirohi	India; tropical, dry
	Sudan Desert	Sudan; tropical, very dry

TABLE 9. SUGGESTED IMPROVER BREEDS IN THE TROPICS AND SUBTROPICS (Devendra and Burns, 1983)

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cont'd

Speciality	Breeds	Country of Origin
Prolificacy	Barbari	
	Boer	
	Black Bengal	India; tropical, dry
	Criollo	S. America; subtropical, dry
	Damascus*	
	Katjang	
	Malabar	
	Ma T'ou	
	Sudan Desert	
	West African Dwarf	West Africa; tropical, humid
Mohair	Angora	Turkey;subtropical, dry
Pashimina (Cashmere)	Kashmiri	Central Asia; high mountain cold
Skins	Black Bengal	
	Maradi (Red Sokoto)	Niger and Nigeria; tropical, dry
	Mubende	Uganda; tropical, dry
Desert (Milk,meat)	Black Bedouin	
	Jamnapari	

TABLE 9. SUGGESTED IMPROVER BREEDS IN THE TROPICS AND SUBTROPICS (Devendra and Burns, 1983)

Particulars	Marginal farmer ++		Landless labourer+++	
	Goat	Buffalo	Goat	Buffalo
1. Milk yield per animal (litres)	365.50	1205.00	369.50	1185.00
2. Income from milk (Rs)	676.17	2306.25	683.57	2207.50
3. Income from dung (Rs)	37.50	168.35	38.00	171.50
4. Gross Income (Rs)	713.67	2474.60	721.57	2379.00
5. Net income per milch animal (Rs)	271.93	216.23	277.65	399.73
6. Net income excluding family labour (Rs)	416.00		1.62	1.22
7. Input-output ratio	1.61	1.09	1.62	1.22

+ In Indian Rupees (1$US = 12 Rs approx.)
++ Based on 11 families
+++ Based on 14 families

TABLE 10. ECONOMIC MILK PRODUCTION FROM GOATS COMPARED TO BUFFALOES IN RURAL INDIA+ (Chauhan and Balishter, 1983).

Type of production system	Ecosystem	Annual rainfall	Target region	Type of product	Priority
Very extensive	Arid	less than 400mm	Near East North Africa	Meat	Low
Extensive	Arid]	less than 400mm	Near East North Africa	Meat	Medium
	Semi-Arid]	400 - 800mm	African highlands Alti-Plano	Meat/Fibre	
Systems combining arable cropping	Semi-Arid] Humid	400 - 800mm more than 1200mm	East Africa West Africa Central America South Asia South East Asia	Meat/Milk	High
Systems integrated with tree cropping	Sub-humid] Humid]	more than 1200mm	Eastern East Africa West Africa South East Asia South Pacific	Meat	High
Intensive grassland	Sub-humid] Humid]	more than 1200mm	East Africa Central America South America	Meat/Milk	High

TABLE 11. TYPE OF PRODUCTION SYSTEM RELATIVE TO ECOZONE, TARGET REGION, PRODUCT AND PRIORITY FOR CONCENTRATING FUTURE EFFORT.

..2/

cont'd

Nomadism	Arid]	less than 400mm	Near East	Meat/Milk	Low
	Semi-arid]	400 -800mm	North Africa		
Transhumance	Arid]	less than 400mm	Near East	Meat	Low
	Semi-arid]	400 - 800mm	Himalayan		
	Highland]	600 - 1000mm		Fibre/Meat	

TABLE 11. TYPE OF PRODUCTION SYSTEM RELATIVE TO ECOZONE, TARGET REGION, PRODUCT AND PRIORITY FOR CONCENTRATING FUTURE EFFORT.